

The following discussion covers how to acquire the current relative humidity from the 1WTH_PRB.

Device Overview

The 1WTH_PRB is a humidity sensor based on the Maxim DS2438 1-Wire Smart Battery Monitor and a Honeywell HIH-4000 humidity sensor. The DS2438 provides two A/D converters and a temperature sensor. The two A/D converters are not alike. One is described as Vsens+ and Vsens- in the Maxim literature and the other as Vad.

- The differential A/D channel Vsens+/- is used to determine the Humidity Output Voltage.
 - The analog conversion channel Vad is used to measure the supply voltage.
 - The supply voltage is required to properly interpret the Sensor Voltage because the HIH-4000 humidity sensor's output is ratiometric.
 - The temperature is used to temperature compensate the Raw Humidity value and determine the Relative Humidity.
- * **Note The 1WTH_PRB is not compatible with Maxim's 1-Wire Viewer software's implementation of a humidity sensor. The DS2438 based design supported by the 1-Wire Viewer software is fundamentally different.**
- * **If used the 1-Wire Viewer software will not correctly interpret the data and will modify the device configuration in a manner that will prevent its operation until the proper configuration is restored.**

The basic steps required to determine the Relative Humidity are:

- 1) Identifying a 1WTH_PRB
- 2) Configuring the device
- 3) Obtaining the device calibration
- 4) Reading the sensors values - Sensor Voltage, Supply Voltage, and Temperature
- 5) Calculating the Relative Humidity

1) Identifying a 1WTH_PRB

The 1WTH_PRB is based on the DS2438 1-Wire Smart Battery Monitor. This means that it will always have a family code of 0x26. It is not important which 1-Wire ROM operation is used to discover the serial number of a DS2438.

A search is initiated to acquire all the ROM codes (family code, serial number, validation crc) of the devices attached to the 1-Wire network.

Search the 1-wire bus

{Reset the bus}
{Initiate a search}

The next step is to determine whether or not the device is actually a 1WTH_PRB.

- If a DS2438 is a 1WTH_PRB then the nonvolatile bytes in the fourth page of the device will contain 0x48, 0x55, 0x4D, 0x49, 0x44, 0x54, 0x33 which is HUMIDIT3 in ASCII.
- The page numbers of the DS2438 are zero based so the fourth page's number is 0x03.

The following interactions show how to read the content of the fourth page (page number 0x03).

{Reset the bus}
{Address the device}
B803 {Copy the content of the fourth page to the scratch pad}
{Reset the bus}
{Address the device}
BE03 {Read the fourth page from the scratch pad}

The content of the fourth page is 48554D4944495433F2 which contains the signature of a 1WTH_PRB.

2) Configuring the device

The device leaves the factory with the proper configuration so it is not expected that the following settings will need to be modified. However, if the configuration settings have been modified they may be restored to the factory defaults.

There are two relevant settings that effect the operation of the device. These are the IAD bit which controls whether or not the Sensor Voltage is being updated and the Offset Register which is a correction factor that is used to adjust the Sensor Voltage.

The IAD bit is located on the first page and the Offset Register is located on the second page. It is important to note that the Offset Register may not be modified while the IAD bit is set to one. Therefore to install the proper configuration the IAD bit must be set to 0, the Offset Register must be set to 0, and then the IAD bit must be set to 1.

Additionally if the contents of the seventh page have been altered the device specific calibration values may have been lost. If these values have been lost the default HIH-4000 calibration data can be written to the seventh page. This will mean the device is not as accurate as it was but it will still be usable. The default value for Slope is 0.031 and Offset is 0.8.

The following interactions show how to restore the device to factory defaults.

	{Reset the bus}
	{Address the device}
4E0000	{Update part of the scratch pad's first page to set IAD = 0}
	{Reset the bus}
	{Address the device}
4800	{Copy first page of the scratch to eeprom/sram}
	{Reset the bus}
	{Address the device}
4E01000000000000	{Update part of the scratch pad's second page, to set Offset Register = 0}
	{Reset the bus}
	{Address the device}
4801	{Copy second page of the scratch to eeprom/sram}
	{Reset the bus}
	{Address the device}
4E0001	{Update part of the scratch pad's first page to set IAD = 1}
	{Reset the bus}
	{Address the device}
4800	{Copy first page of the scratch to eeprom/sram}

3) Obtaining the device calibration

The device has two calibration factors stored in the nonvolatile memory of the seventh page. These calibration factors are the slope and offset of the best fit line correlating Humidity Output Voltage to Raw Humidity at a Supply Voltage of 5vdc. These values do not change so there is no need to read them more often than upon discovery of the device. Their application is demonstrated in the Calculating the Raw Humidity section.

The content of the seventh page is described by:

- Byte_0 = Constant 0xAA
- Byte_1 = Constant 0xAA
- Byte_2 = Most significant byte of the offset
- Byte_3 = Least significant byte of the offset
- Byte_4 = Most significant byte of the slope
- Byte_5 = Least significant byte of the slope
- Byte_6 = Reserved
- Byte_7 = Reserved

The units of the Offset and Slope have been altered to improve accuracy. The values must be interpreted with the following equations:

- Offset = ((Byte_2 * 256) + Byte_3)/10000
- Slope = ((Byte_4 * 256) + Byte_5)/100000

The following steps show how to obtain the content of the seventh page.

```

      {Reset the bus}
      {Address the device}
B806  {Copy the content of the seventh page to the scratch pad}
      {Reset the bus}
      {Address the device}
BE06  {Read the seventh page from the scratch pad}
      Reply: BE06AAAA1B2E0CC8BB00
      {Seventh page content starts in third byte}
```

- Byte_0 = 0xAA = 170
- Byte_1 = 0xAA = 170
- Byte_2 = 0x1B = 27
- Byte_3 = 0x2E = 46
- Byte_4 = 0x0C = 12
- Byte_5 = 0xC8 = 200
- Byte_6 = 0xBB = 187
- Byte_7 = 0x00 = 0

Plugging in the values returned into the equations yields:

- Offset = ((27 * 256) + 46)/10000 = 0.6958
- Slope = ((12 * 256) + 200)/100000 = 0.03272

4) Reading the sensors values - Sensor Voltage, Supply Voltage, and Temperature

The Sensor Voltage, Supply Voltage, and Temperature must be retrieved from the device to perform a humidity calculation. The Sensor Voltage is being constantly monitored by the DS2438. However, the Supply Voltage and Temperature measurements are only update in response to specific commands. Some application may find it desirable to update the Supply Voltage and Temperature at slower intervals to improve overall system latency. Once the desired sensor values have been updated the first page must be retrieved to obtain the raw values.

The content of the first page is described by:

- Byte_0 = Status/Configuration
- Byte_1 = Least significant byte of the temperature
- Byte_2 = Most significant byte of the temperature
- Byte_3 = Least significant byte of the Supply Voltage
- Byte_4 = Most significant byte of the Supply Voltage
- Byte_5 = Least significant byte of the Humidity Output Voltage
- Byte_6 = Most significant byte of the Humidity Output Voltage
- Byte_7 = Threshold

Below are the interactions required to update and collect all the values.

```
44  {Reset the bus}
    {Address the device}
    {Convert Temperature}
    Wait 10ms for conversion to complete
    {Reset the bus}
    {Address the device}
B4  {Convert Supply Voltage}
    Wait 10ms for conversion to complete
    {Reset the bus}
    {Address the device}
B800 {Copy the content of the first page to the scratch pad}
    {Reset the bus}
    {Address the device}
BE00 {Read the first page from the scratch pad}
     Reply: BE0001D016DE01D80100
    {First page content starts in third byte}
```

```
Byte_0 = 01 = 1
Byte_1 = D0 = 208
Byte_2 = 16 = 22
Byte_3 = DE = 222
Byte_4 = 01 = 1
Byte_5 = D8 = 216
Byte_6 = 01 = 1
Byte_7 = 00 = 0
```

$$\text{Temperature} = (\text{Byte}_1 + (\text{Byte}_2 * 256)) / 256$$
$$\text{Temperature} = (208 + (22 * 256)) / 256 = 22.8125\text{DegC}$$

$$\text{Supply Voltage} = (\text{Byte}_3 + (\text{Byte}_4 * 256)) * 0.01$$
$$\text{Supply Voltage} = (222 + (1 * 256)) * .01 = 4.78\text{V}$$

$$\text{Sensor Voltage} = (\text{Byte}_5 + (\text{Byte}_6 * 256)) / 4096$$
$$\text{Sensor Voltage} = (216 + (1 * 256)) / 4096 = 0.1152\text{V}$$

5) Calculating the Relative Humidity

With all the values collected the Humidity can be calculated with the following approach.

- Calculate the Humidity Output Voltage from the Sensor Voltage and the Supply Voltage.
- Calculate the Raw Humidity from the Humidity Output Voltage and the humidity sensor's Slope and Offset.
- Correct the Raw Humidity values by applying temperature compensation to yield the Relative Humidity. The equations below perform this process.

$$\text{Humidity Output Voltage} = (\text{Sensor Voltage} / \text{Supply Voltage}) * 85.65$$
$$\text{Humidity Output Voltage} = (0.1152 / 4.78) * (85.65) = 2.064$$

$$\text{Raw Humidity} = (\text{Humidity Output Voltage} - \text{Offset}) / \text{Slope}$$
$$\text{Raw Humidity} = (2.0641 - 0.6958) / 0.03272 = 41.8185$$

$$\text{Relative Humidity} = (\text{Raw Humidity}) / (1.0546 - (0.00216 * \text{Temperature}))$$
$$\text{Relative Humidity} = (41.8185) / (1.0546 - (0.00216 * 22.8125)) = 41.6 \%RH$$

This completes the process of calculating Relative Humidity. The data used during the creation of this document was taken at room temperature. Temperature compensation will generally shift the Relative Humidity by three percent for a twenty five degree Celsius change.